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LESSONS LEARNED FROM OPERATION AND MAINTENANCE OF COMBINED SEWER OVERFLOW DETENTION BASINS

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ABSTRACT

In Southeast Michigan, the recognition of combined sewer overflows as a major problem prompted the institution of the Rouge River National Wet Weather Demonstration Program. This program includes the construction of nine CSO detention basins of varying sizes and design. Collection and analysis of flow rates, water quality parameters and operation and maintenance information is still ongoing. One of these basins, the Inkster CSO basin has been in operation since December 1996.

This paper will concentrate on the lessons learned about CSO facilities during the data collection phase of the demonstration program. The focus of the paper is on design and operational issues encountered during the evaluation program

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KEYWORDS

Combined sewer overflow, in-system storage, first flush

INTRODUCTION

Combined Sewer Overflows (CSOs) have been identified as major sources of pollution in the United States. In Southeast Michigan, the recognition of this problem prompted the institution of the Rouge River National Wet Weather Demonstration Program. As part of this program, CSO control facilities of varying sizes and design have been constructed to provide treatment of CSO discharges along the Rouge River (see Figure 1, RPO 1996). One of these basins, the Inkster CSO Detention Basin, has been in operation since December 1996.

An intensive monitoring program was negotiated with the Michigan Department of Environmental Quality (MDEQ) and the Rouge Program Office (RPO) to collect influent and effluent water quality parameters to be used in determining the performance of the CSO basins. This paper will concentrate on the lessons learned about CSO facilities during the data collection phase of the demonstration program including facility design considerations, facility operations and preliminary observations.

PROJECT BACKGROUND

The Inkster CSO Detention Basin is a 3.1 MG CSO detention basin serving a combined sewer tributary area of 833 acres and separate area of 308 acres (see Table 1.) The NPDES permit required sizing the CSO facility to provide a 20minute hydraulic detention time for the peak flow rate from a 1 -year/1 -hour storm event. The facility was constructed with an additional 1.1 MG compartment to completely capture the first flush of a storm event. A collector sewer transports flow in excess of the regulator capacity from 10 regulators into the influent pump station wetwell. To prevent basement flooding, the influent pump station and screens were sized to transport the maximum surcharge capacity of the existing combined sewer outfalls. This resulted in a 500 cfs pump station, which is the peak flow resulting from a 10-year/24-hr. storm event on the tributary combined sewer area. The CSO is pumped first into the first flush compartment, then through two parallel flow-through compartments (see Figure 2.) Treated CSO flow in excess of the capacity of the compartments is discharged to the Rouge River. CSO flow captured in the compartments is dewatered back to the interceptor at the conclusion of the storm event. This portion of the flow is transported to the City of Detroit's Wastewater Treatment Plant.

Disinfection is accomplished through the addition of sodium hypochlorite. There are three possible locations where sodium hypochlorite can be injected into the flow stream. At the influent wetwell, CSO pump discharge and at the effluent trough. The primary mode of operation called for flow paced sodium hypochlorite injection in the pump station wetwell.

FACILITY DESIGN CONSIDERATIONS

The upstream collector sewers and influent pump station wetwell provides significant storage capacity, in addition to the capacity provided by the detention basin compartments. This capacity was discounted as not being important during the design stage of the facility. Operational experience has demonstrated that the 1.1 MG storage capacity provided prior to the basin compartments completely captures the CSO generated by a significant number of small size storm events. Between June 1997 and April 1999, 35 of 81 storm events were captured by the storage capacity in the collector sewers and the pump station wetwell.

The use of a f i rst flush tank has proven to be an excellent facility design consideration based on data evaluation and anecdotal information. In addition, review of the total suspended solids (TSS) data collected during the program shows a distinct first flush prof ile (see Figu re 3.) After storm events, the f i rst f lush captu re compartment requires more effort to clean than the other two flow-through compartments.

The design flow for the CSO basin is based on 20-minute detention of 1 -year, 1 -hour flows. This results in a peak flow rate of 228 cfs. However, to eliminate the possibility of basement flooding due to the construction of the basin required a peak flow rate of 500 cfs. During the design phase of the project, the IVIDEQ's policy required that all flows should pass through the CSO basins. This resulted in the need to size screens, chemical feed pumps and flow meters to span a range of flows from 0-500 cfs. This proved to be a large range for the flow meter, especially during low flows and affected flow pacing of chemical feed.

During actual operation, 72 of 81 CSO events generated peak flow rates that were less than 95 cfs. Consequently, a staged pumping scheme should be considered. A smaller set of pumps in the 30 cfs to 60 cfs range to handle the typical storm events, with additional larger pumps for the infrequent but severe storm events.

Regulatory requirements during the design phase also led to the installation of odor

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control scrubbers. To date, these scrubbers have not been used.

FACILITIES OPERATIONS

Design engineers have paid lip service to the involvement of operation and maintenance during facility design. Typically, this involvement is in the form of sending plan sets to O&M personnel to review prior to final design. The design of the Inkster CSO Basin benefited from the inclusion of the CSO O&M Manager as part of the Value Engineering Team. It also benefited because the manager was able to have input on equipment recommendations, as well as being involved in the construction phase of the project.

Another issue is that in some cases, even if O&M personnel are involved in the design, they may not be involved in subsequent construction phase decisions. Sometimes these decisions involve the elimination of seemingly inconsequential pieces of equipment such as slop sinks, sample preparation table or changes in types of equipment.

Some of the issues encountered during facility operations include the need to provide a dedicated crew for operation and maintenance of these facilities. The maintenance personnel should be involved at the onset of the basis of design and final design. It is also important to include the operating personnel during any Value Engineering that is done for the facility. Usually, operations personnel suggestions may not survive the VE and construction stage of the project.

Most of the operational issues encountered during the operation of the basin have centered on the influent flow meter and Sodium Hypochlorite feed system.

Influent Flow Meter

The influent flow meters for the basin are Accusonics Multipath flow meters. The meters are located immediately upstream of the influent pump station wet-wells. At the beginning of the evaluation program, the Sodium Hypochlorite feed was flow paced, based on the flow meter measurement. The following problems were encountered:

- The basin influent pumps on - off sequence affected the accuracy of the flow meter readings. This also affected the CSO volume recorded for each event.
- The meter inaccuracy made it difficult to flow pace sodium hypochlorite.

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The CSO volume estimation has been accomplished with the help of level measurements in the influent sewer and basin compartments, as well as pump run times and effluent Parshall flume measurements.

The hypochlorite feed was changed and paced to influent pump flow, such that the Hypochlorite feed would not start until the CSO pumps start.

Sodium Hypochlorite Feed System

The design of the disinfection system called for storage of enough sodium hypochlorite to disinfect , at peak dosage rates, CSO resulting from back-to-back 1-year, 1 -hour storms.

- During one of the events, the City of Inkster's CSO basin ran out of bleach. This was due to the length of the event.
- The degradation in the strength of the Sodium Hypochlorite, due to initial dilution and length of storage. Sodium hypochlorite concentration will drop during extended storage from 6% to about 3%. This affects the bacteria kill. Provide the ability to modify disinfectant dose based on measured solution strength.
- Problems with Hypochlorite feed pumps.
- Selection of adequate Hypochlorite feed to achieve required fecal coliform kill and TRC less than 1 mg/l.

The lessons learned in the operation of the CSO basin result primarily from trying to solve the above problems.

- There is a need to establish a minimum amount of hypochlorite feed available. This minimum amount should be increased in the winter (December to April). The winter events tend to last longer than events from spring/summer, increasing the chance of a back-to-back event. It also increases the likelihood of running out of disinfectant.
- There is a need to build a sufficient database to aid in reducing hypochlorite feed during an event. This database will help in maintaining effluent TRC concentrations at a reasonable level and achieve the required kill.
- There is a need to set up monthly testing of the stored hypochlorite, as well as testing after delivery and dilution. The test results should be used in selecting the feed rate, as well as deciding when to re-order chemical.

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The design of this facility anticipated that most of the basin operations would take place under inclement weather. These conditions include power outages, non-functional telephone lines, and poor road conditions. It is imperative that extensive backup systems be provided to ensure the protection of public health. The design should also realize that some of these issues though minor lasts for as long as the facility is used.

PRELIMINARY OBSERVATIONS

Other findings related to the treatment of CSO discharges are summarized below:

The influent flow rate to the CSO facility is much less than the design flows. Typical influent flow rates of 50 cfs are common, compared with design flows of 200 cfs. About 15% of the storms monitored approached a peak CSO event flow rate of 125 cfs.

- The use of an influent pump station masked the presence of a first flush effect for CBOD5. The first flush effect was clearly observed for TSS.
- A significant portion of the pollutant load removal by the facility is accomplished through CSO volume capture, as opposed to settling during flow-through treatment (see Table 2.)
- Difficulty in achieving a completely remotely controlled CSO facility. Part of the reason is the need to collect grab samples for DO, pH, fecal coliform and TRC. In addition, there is always the possibility of equipment break down during the events.
- Frequency of operation is important, because it allows adequate use of equipment. The more frequently operated basins typically get the most attention. There is also a sense of urgency in the repair of malfunctioning equipment.

CONCLUSION

The lessons learned from the Rouge River National Demonstration Project extends beyond the treatment efficiency of the CSO detention basins. The findings presented in this paper will be useful to designers and operators considering CSO Control facilities. These types of operational experiences are not usually publicized; it is our hope that designers will find it useful.

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Table 1. CSO Basin and Tributary Area Characteristics

		Inkster
Basis of Design	Design Storm	1 Yr, I Hr
	Rainfall	1.00 in
	Detention Time	20 Minutes
Basin Characteristics	CSO Flow Rate (Design Storm)	228 CFS (0.27 CFS/Acre)
	Basin Volume	2.0 + 1.1 MG
	Wet Well Storage	0.4 MG
	In-System Storage	1.0 MG.
	Innovative Features	1.1 MG First Flush
Tributary Area Characteristics	Combined Area	833 Acres
	Other Tributary Area	308 Acres Storm Water
	Dry Weather Flow	2.6 CFS
	Interceptor Capacity	15.5. CFS (0.019 in/hr)
	Interceptor to DWF Ratio	5.9

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Table 2. General Operating Statistics through May 31,1998

		Inkster*
Operating Mode		First Flush Capture, then Flow -Through
Evaluation Period		June 1. 1997 - May 31, 1998
Influent Events	Influent Events	45
	Rainfall Total for Capture	Up to 0.82 in
	Total Volume	103.7 MG
	Total TSS Load	124,000 LBS
	Total CBOD Load	24,200 LBS
Overflow Events	Effluent Events	9
	Total Volume	29.1 MG
	Total TSS Load	23,600 LBS
	Total CBOD Load	2,600 LBS
Percent Influent Capture	Volume	72
	TSS Load	81
	C80135 Load	89

* NOTE:. February 17-21, 1997 Event Not Included for Volume and Load Calculations

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